CENTRAL NORTH PACIFIC ALBACORE SURVEYS JANUARY 1954 - FEBRUARY 1955

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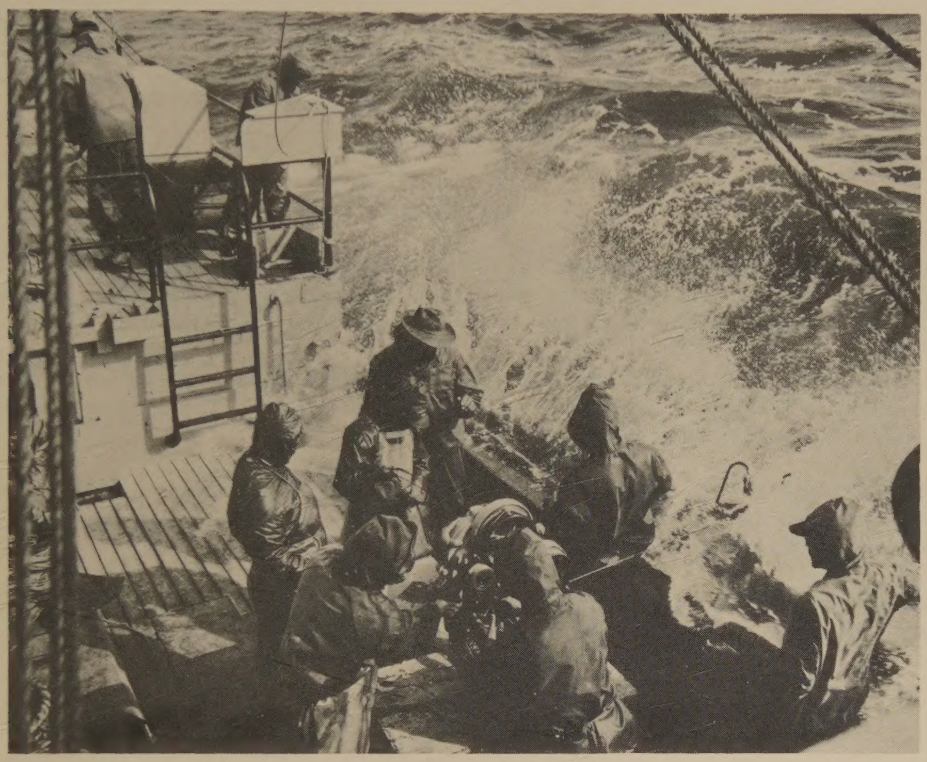

CENTRAL NORTH PACIFIC ALBACORE SURVEYS, JANUARY 1954 - FEBRUARY 1955

By

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Honolulu, T. H.

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ABSTRACT

This report embodies the fishing results from seven exploratory cruises in the North Pacific during the one fall and two winter seasons between January 1954 and February 1955. These results are supplemented by Japanese commercial longline catch data for the same period.

Albacore, Germo alalunga (Bonnaterre), were caught during all three seasons on longlines and were taken by trolling only during the fall and second winter. The longline-caught albacore covered a wider size range than did the troll-caught fish.

There appears to be a parallel north-south shift with the seasons of the albacore population and the transition zone between the North Pacific Current and the Aleutian Current. During the winter both were located south of their fall positions.

Also included in this report are discussions of the vertical distribution, sex composition, and tagging of albacore as well as data on the miscellaneous species of fish taken.

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This is the first in a projected series of reports by the Pacific Oceanic Fishery Investigations (POFI) on the distribution of albacore, Germo alalunga (Bonnaterre), in the Pacific north of Hawaii. Financial support for the studies was provided under the Saltonstall-Kennedy Act (Public Law 466-83rd Congress).

Albacore are widely distributed in the tropical and temperate Pacific. They are taken with longline gear along with yellowfin tuna in the central and western equatorial waters (Murphy and Shomura 1953b, Murphy and Otsu 1954) and support commercial fisheries in the North Temperate Zone. During the summer and early fall, albacore are taken in commercial quantities by trolling and live-bait fishing off the west coast of North America from southern Baja California as far north as British Columbia (Clemens 1955). In addition, there are the Japanese fisheries--a pole-and-line fishery operating off the coast of Japan during the early summer and early winter and a winter longline fishery in the area from Japan east to Midway Island (Suda 1954).

The present paper reports the results of three fishing cruises of the John R. Manning and the incidental catches of four hydrographic cruises of the Hugh M. Smith and the Charles H. Gilbert over the period January 1954 to February 1955 (table 1). Also incorporated are the catches of a portion of the Japanese albacore fleet that operated in the same or contiguous areas during the survey. The California Department of Fish and Game participated in the first series of albacore cruises (January-March 1954, table 1), surveying west to 140°W. longitude; their results will be published elsewhere.

Through this and subsequent reports we will use the vernacular names of the fishes. These, with their commonly accepted scientific names, are listed in the Appendix as Table 23.

ACKNOWLEDGMENTS

We are indebted to fellow staff members and officers and crew members of the vessels for their part in carrying out the field work. We would especially like to thank Mr. Toshizo Nomura of the Kanagawa Prefecture Fisheries Experiment Station for making available Japanese catch records. The vertical and surface temperature contours were prepared by Mr. T. S. Austin and the writers. Mr. Richard N. Uchida assisted in summarizing the data and Mr. Tamotsu Nakata drew the figures.

DESCRIPTION OF FISHING GEAR AND OPERATIONAL METHODS

Two types of fishing, longlining and trolling, were used to sample the North Pacific albacore. The longline method of subsurface fishing was developed by Japanese fishermen. Shapiro (1950) gives an excellent discussion of the history of the gear, and Shimada (1951) gives details on its construction. The gear used for this survey was essentially the same as that described by Mann (1955). A set consisted of about 60 "baskets" or skates of gear joined end on end, with 13 hooks on each basket (fig. 1). One half of the gear was set with 5-fathom floatlines and the other with 15-fathom floatlines. Frozen sardine and herring were used for bait on all three longline fishing cruises. The gear was set at daybreak in a little over an hour. Hauling commenced at

Table 1.--Operational data on POFI cruises in the North Pacific, January 1954-February 1955

Vessel	Cruise	Period of operation	General area covered		Type of operation
J. R. Manning	19	Jan.-Mar. 1954	22°-36°N.	145°W.-160°W.	Longline, trolling
H. M. Smith	25	Jan.-Mar. 1954	22°-40°N.	140°W.-165°W.	Hydrographic, trolling
J. R. Manning	22	Sept.-Nov. 1954	22°-47°N.	159°W.-177°W.	Longline, trolling
C. H. Gilbert	17	Sept.-Nov. 1954	22°-45°N.	160°W.-171°E.	Hydrographic, trolling
J. R. Manning	23	Dec. 1954-Feb. 1955	22°-37°N.	157°W.-180°	Longline, trolling
C. H. Gilbert	18	Dec. 1954	22°-40°N.	157°W.-162°W.	Hydrographic, trolling
H. M. Smith	27	Jan.-Feb. 1955	22°-37°N.	158°W.-170°E.	Hydrographic, trolling

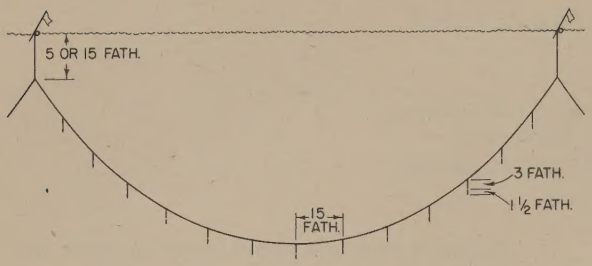

Figure 1.--Schematic view of one basket of the longline gear used in albacore fishing by POFI vessels.

noon and was done in the reverse order of setting. The hauling time varied from station to station depending on the number of baskets fished and on the prevailing weather conditions (tables 14 to 16, Appendix) but usually took about 4 hours.

Three types of trolling--incidental surface, deliberate surface, and experimental deep trolling--were used to sample the albacore in this survey. Incidental surface trolling was done at a vessel speed of about 8 knots on the hydrographic and fishing cruises during all daylight runs between stations. Two to five lines were fished, with a boom rigged out amidships when more than three lines were used. The trolling lines, of No. 261 hard-laid cotton line, trailed from 15 to 25 fathoms beyond the stern. The inboard end of the line was secured to a shock-absorber made of a pair of galvanized steel springs 12 inches long and 1-1/2 inches in outside diameter. The outboard end of the line was joined by a swivel to 1-1/2 fathoms of No. 18 stainless steel wire leader. During the course of each cruise, a variety of lures were used. These included red, white, and amber-colored plastic jigs and feather jigs with plastic or lead heads. Several combinations of white, red, green, and brown feathers were used.

Deliberate surface trolling with five lines (three from the stern and two from the trolling boom) was done at each longline fishing station for 2 hours along the "soaking" line. The makeup of the trolling gear was exactly as described for incidental trolling, but the vessel was slowed to 6 - 6-1/2 knots.

Deep trolling at a vessel speed of 3 to 5 knots was tried at seven longline stations on Manning cruise 23 (December 1954-February 1955). The gear had four 10-fathom branch lines (261 cotton line with 1-1/2 fathoms of No. 18 wire leader) spaced at 15-fathom intervals on a mainline of 5/32-inch cable. The mainline was weighted with either a 50-pound semi-depressor or a "kite-type" depressor. Both feather lures and fresh frozen sardine were used as bait, the latter being secured to the hook with linen twine.

WEATHER

The success of fishing depends to a certain extent on the prevailing weather conditions. Longlining becomes hazardous and therefore is generally not attempted in very rough seas or when the winds reach 20 to 30 knots. During the three longline cruises storms were encountered which interrupted fishing for 1 to 7 days at a time, and of a total of 91 days spent north of 30°N. latitude, 39 days (43 percent) were considered too rough for longlining (table 2).

ALBACORE

Distribution and Abundance

Longline Catches. A total of 52 longline stations were fished during the three cruises. Albacore were taken at 20 stations but the catch on any one station was generally small (tables 11 to 13, Appendix). A notable exception was a catch of 42 albacore at station 8 (33°58'N., 159°44'W.) on Manning cruise 19.

Two things are apparent from the albacore catch distribution (fig. 2). First, the northern limit of the albacore distribution was not defined because a combination of adverse

Table 2.--Summary of weather conditions encountered on POFI cruises north of 30°N. latitude

Cruise	Total number of days spent north of 30°N.	Good weather		Rough weather (seas >5, winds over 20 kt.)
		Number of days fished	Days spent traveling	
Manning 19	25	12	1	12
Manning 22	41	14	9	18
Manning 23	25	15	1	9
Total	91	41	11	39

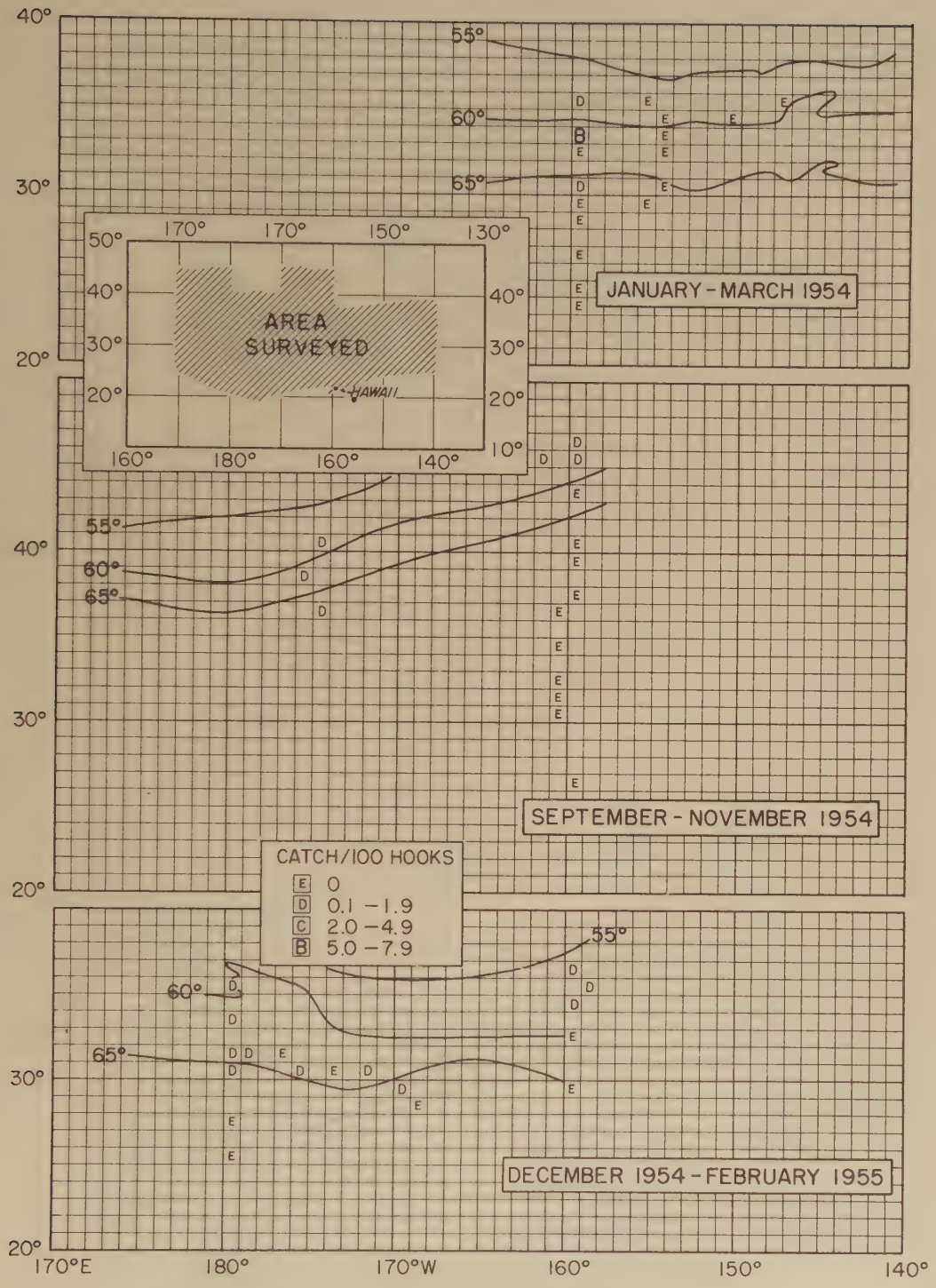

Figure 2.--Summary of POFI longline albacore catches in the North Pacific.

weather and logistic limitations made fishing farther north impossible. Second, there was a seasonal shift in the southern limit of the albacore catches, the winter limit being farther south than the fall limit. The magnitude of this shift was about equal to the movement of certain surface isotherms, e.g., the 60°F. isotherm located between 41° and 42°N. on 170°W. during the fall moved south to between 32° and 33°N. at the same longitude during the following winter (fig. 2).

There are a number of records of Japanese commercial fishing in the general zone in which we took albacore during the winter of 1953-54. These are summarized in figure 3 and table 3. Most of the Japanese effort was concentrated to the west of 180° (fig. 3) whereas we surveyed the area from 180° east to 150°W. (fig. 2). Japanese fishing was confined to the zone lying between 28° and 35°N. latitude. The best Japanese catches were made during December and January, when a number of areas showed catches of 5 or more albacore per 100 hooks. Longitudinally, their best area appears to have been immediately west of 180° longitude (170°E. to 180°), however, from table 3 it is apparent that significant catches were made as far west as 141°E. during December 1953. In POFI's fishing during January-March 1954 and 1955 at only one station was the albacore catch rate as high as those of the good catches (>5.0 per 100 hooks) made by the Japanese to the west (compare figs. 2 and 3). This does not mean that the area immediately north of Hawaii is less productive than the area to the west, since only limited experimental fishing has been completed thus far, furnishing only a rough estimate of albacore availability. It should be added here that the catch rates of the POFI 13-hook gear may not be strictly comparable with the catch rates of the Japanese 6-hook gear. Although the relative efficiency of the two types of gear in taking albacore has not yet been determined, it has been shown for the central equatorial Pacific yellowfin tuna that 11-hook gear is less efficient in terms of catch per 100 hooks than 6-hook gear (Shomura and Murphy 1955).

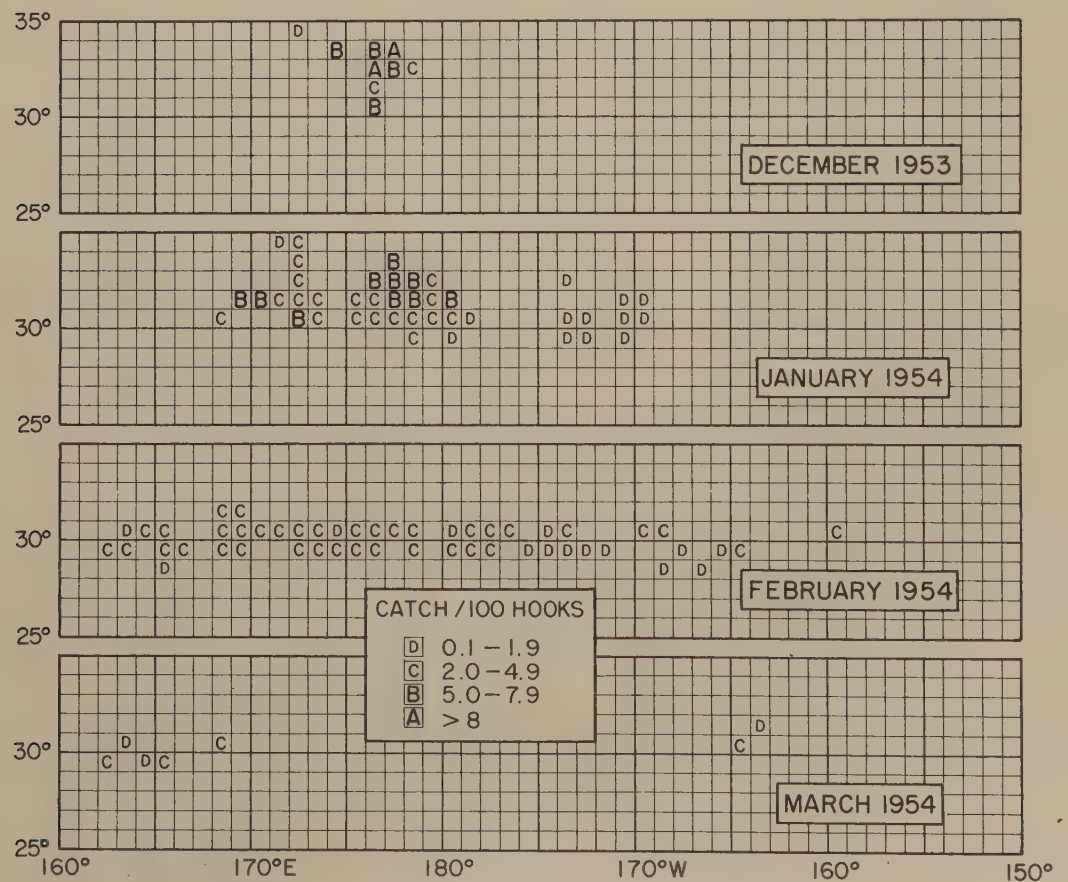

Figure 3.--Summary of some Japanese longline albacore catches (data from individual vessel reports transmitted to POFI by Mr. Toshizo Nomura).

Table 3.--Summary of Japanese commercial longline albacore catches (catch per 100 hooks) in the North Pacific. Data taken from Nomura et al. (1953-54)

Month	Area of fishing		Number of vessels	Times fished	Albacore per 100 hooks
	Latitude	Longitude			
Sept. 1953	37°-39°N.	158°-170°E.	3	54	0.04
Oct. 1953	37°-38°N.	151°-152°E.	1	16	0.03
	36°-38°N.	168°-174°E.	4	80	5.57
Nov. 1953	30°-35°N.	150°-159°E.	19	386	1.27
	32°-35°N.	160°-161°E.	2	34	4.68
	28°-32°N.	173°-174°E.	1	18	1.31
	33°-40°N.	150°-161°E.	6	106	1.34
	33°-38°N.	162°-172°E.	4	58	4.32
	32°-37°N.	174°-179°E.	1	23	2.84
	31°-35°N.	150°-174°E.	22	438	1.58
	25°-34°N.	179°-161°W.	4	100	0.65
	34°-35°N.	180°-170°W.	1	14	2.77
	34°-40°N.	150°-169°E.	11	187	2.49
Dec. 1953	30°-34°N.	158°-160°E.	11	204	2.72
	31°-35°N.	160°-163°E.	7	131	3.82
	30°-34°N.	170°E.-180°	14	234	6.86
	34°-35°N.	145°-147°E.	13	249	0.51
	30°-32°N.	141°-150°E.	7	86	4.73
	26°-31°N.	179°-168°W.	2	51	0.56
	32°-34°N.	172°-170°W.	1	16	1.09
	35°-37°N.	150°-174°E.	3	60	7.33
	30°-34°N.	151°-179°E.	32	569	4.76
	35°-38°N.	143°-148°E.	8	109	8.52
	30°-35°N.	141°-150°E.	20	335	1.69
	30°-35°N.	133°-139°E.	152	762	0.09
Jan. 1954	28°-30°N.	141°-145°E.	40	732	2.81
	28°-30°N.	150°-157°E.	2	38	3.07
	28°-30°N.	170°-178°E.	2	33	1.38
	30°-32°N.	151°-163°E.	6	123	2.29
	30°-32°N.	158°-168°E.	30	595	5.42
	30°-34°N.	175°-179°E.	7	123	5.30
	29°-30°N.	179°-170°W.	1	20	2.34
	30°-32°N.	170°-169°W.	1	18	0.72
	22°-30°N.	132°-171°E.	109	1559	2.42
	30°-34°N.	150°-178°E.	43	841	4.91
	35°-38°N.	142°-144°E.	14	132	6.98
	29°-35°N.	140°-148°E.	51	743	2.69
Feb. 1954	28°-30°N.	150°-160°E.	11	224	3.26
	28°-30°N.	160°-170°E.	13	265	3.11
	29°-30°N.	170°-179°E.	7	143	2.97
	29°-33°N.	149°-164°E.	3	60	3.21
	29°-31°N.	160°-173°E.	10	203	3.59
	30°-31°N.	168°-179°E.	6	131	3.16
	23°-30°N.	171°-158°W.	1	28	0.03
	30°-32°N.	154°-179°E.	19	394	3.40
March 1954	23°-30°N.	152°-157°E.	14	241	1.48
	29°-30°N.	160°-168°E.	5	97	3.21
	30°-32°N.	149°-166°E.	6	131	1.65
	29°-33°N.	160°-166°E.	7	156	3.43
	27°-30°N.	179°-167°W.	2	40	0.66
	30°-33°N.	150°-166°E.	13	287	2.82

Troll Catches. The albacore catches from both incidental and deliberate surface trolling are combined in figure 4. During January-March 1954 no albacore were taken in the 1,095 line-hours of trolling (fig. 4A), although albacore were taken on the longline gear during this period (fig. 2). During the fall of 1954 (figs. 4B and 4C), trolling yielded 56 albacore in 1,701 line-hours while during the following winter only 4 albacore in 2,911 line-hours. The highest catch rate of 8.8 albacore per 10 line-hours was made during the fall at about 42°N. latitude on 172°E. longitude (fig. 4B).

There is a striking contrast between the latitudinal locations of the fall and winter troll catches, for most of the fall catches were made north of 40°N. while the winter catches were all made between 30° and 35°N. latitude, a southward displacement roughly parallel to that of the longline catches.

No albacore or other fish were taken on the deep trolling gear used on Manning cruise 23. Albacore, however, were present below the surface in these waters as shown by the longline catch at five of the seven stations at which both types of gear were fished (table 4). We cannot yet consider deep trolling a complete failure, for only 7-1/2 hours have been devoted to this type of fishing.

Surface Sightings. To evaluate the relative productivity of the different areas, observations were made on bird flocks, fish schools, and aquatic mammals. During the period of our observations, the results (table 5) show that birds were most abundant during the fall months. This is of interest since the trolling records (fig. 4) show that most of the troll-caught albacore were taken during this period. The majority of the birds occurred to the south, however, between 30°N. and 40°N. latitude, whereas most of the albacore were taken north of 40°N. latitude.

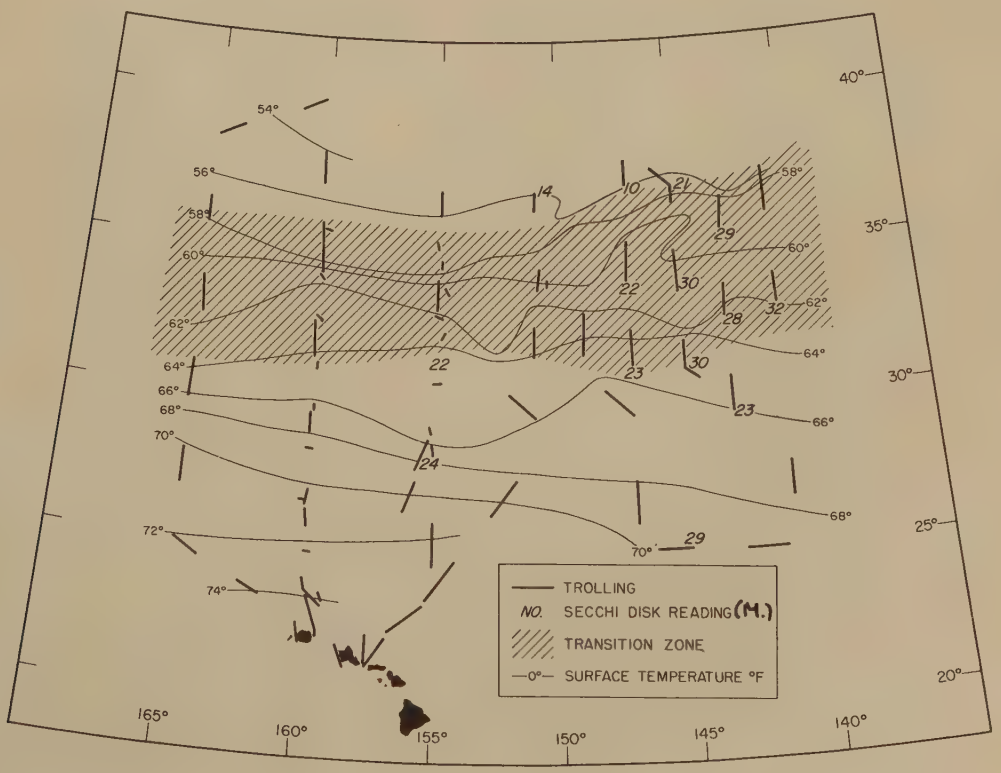

Figure 4A.--Albacore catch per 10-line hours of surface trolling; surface temperature contours and Secchi disk readings are indicated, Manning cruise 19 and Smith cruise 25, January-March 1954.

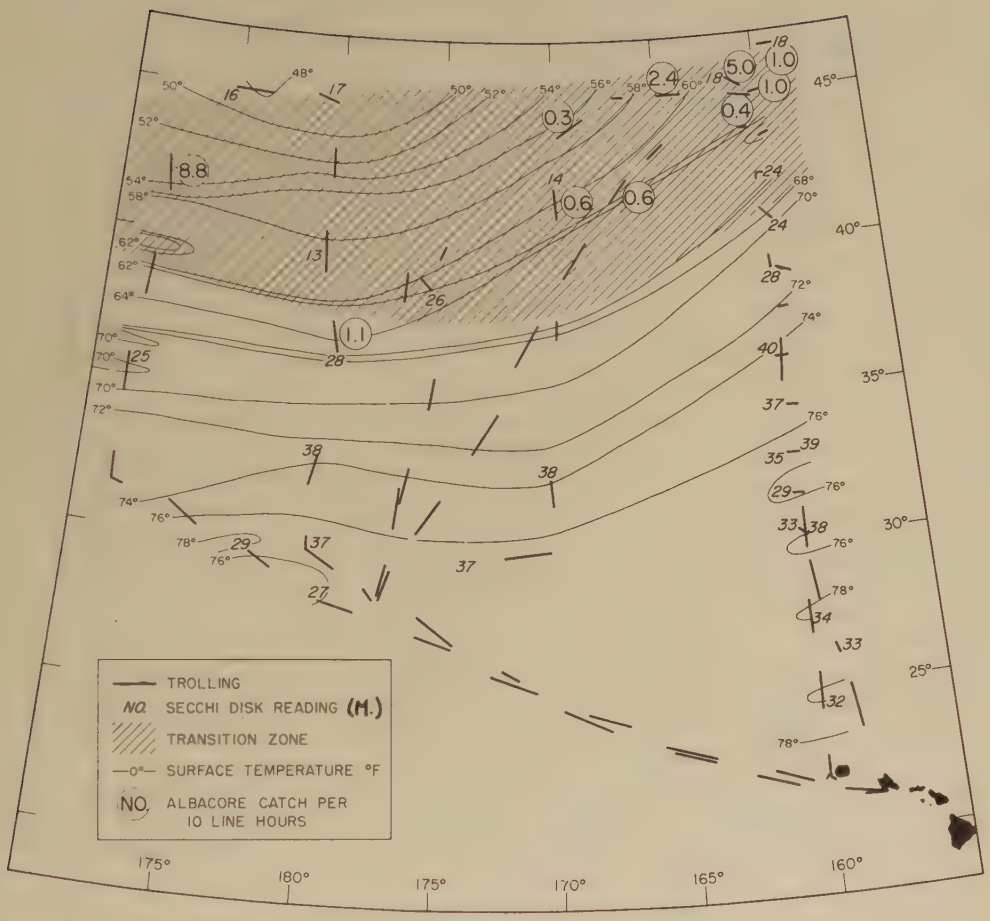

Figure 4B.--Albacore catch per 10-line hours of surface trolling; surface temperature contours and Secchi disk readings are indicated, Manning cruise 22 and Gilbert cruise 17, September-November 1954.

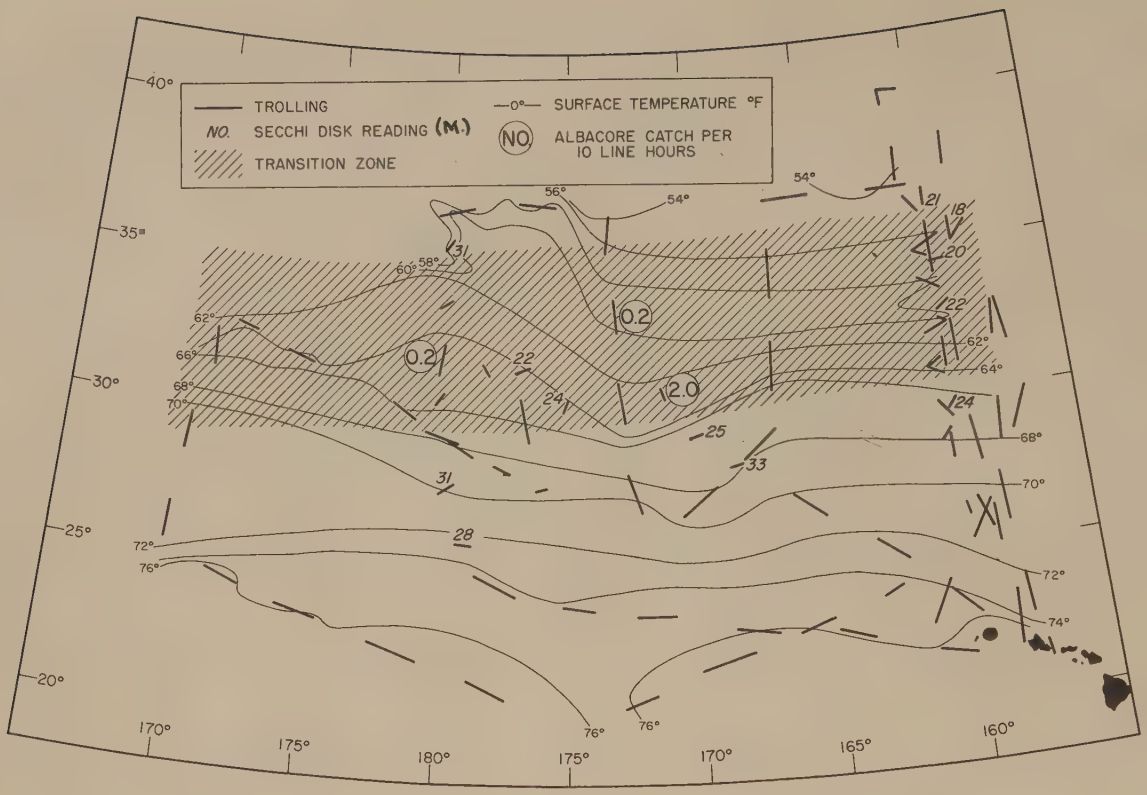

Figure 4C.--Albacore catch per 10-line hours of surface trolling; surface temperature contours and Secchi disk readings are indicated, Manning cruise 23, Gilbert cruise 18, and Smith cruise 27, December 1954-February 1955.

Table 4.--Results of the deep trolling experiment and a summary of the longline albacore catches for the same days, John R. Manning cruise 23, December 1954-February 1956

Date	Station	Hours trolled	Type of bait	Catch	Albacore catch on longline gear
Dec. 9	5	1	Feather	0	7
Dec. 14	8	1.5	Feather	0	7
Jan. 16	12	1	Sardine	0	5
Jan. 17	13	1	Sardine	0	1
Jan. 27	16	1	Sardine	0	0
Jan. 30	18	1	Sardine	0	0
Feb. 1	20	1	Sardine	0	2

Table 5.--Observations of bird flocks, fish schools, and mammals sighted more than 80 miles from land in the North Pacific[1/]

	Location		Nature of observation
	Latitude	Longitude	
1954			
Jan. 24	38°35'N.	164°35'W.	Flock (11-50 birds) of petrels and shearwaters working over unidentified tuna school
Jan. 24	38°30'N.	164°50'W.	Unidentified whale sighted
Jan. 26	37°37'N.	160°09'W.	Seal sighted
Mar. 3	33°40'N.	143°05'W.	3 porpoises sighted
Mar. 16	22°40'N.	155°33'W.	Flock (11-50 birds) of terns working over unidentified, medium-sized tuna school
Mar. 16	22°40'N.	155°33'W.	Flock (200 birds) of terns working over unidentified, large-sized tuna school
Sept. 20	27°01'N.	159°59'W.	Unidentified whale sighted
Sept. 22	32°40'N.	159°54'W.	Four unidentified whales sighted
Sept. 29	42°45'N.	159°40'W.	Several albacore sighted breaking water
Oct. 3	44°25'N.	168°30'W.	Several albacore sighted breaking water
Oct. 9	39°20'N.	169°20'W.	Flock (< 10 birds) of petrels and/or shearwaters
Oct. 10	37°00'N.	171°10'W.	Flock (11-50 birds) of petrels and/or shearwaters
Oct. 10	37°00'N.	171°10'W.	Flock (> 50 birds) of petrels and/or shearwaters
Oct. 11	33°20'N.	173°30'W.	Flock (> 50 birds) of terns, petrels, shearwaters; some evidence of fish school
Oct. 17	32°30'N.	176°20'W.	Flock (200-300 birds) of boobies, petrels, and/or shearwaters; evidence of fish school
Oct. 17	32°10'N.	176°30'W.	Flock (75 birds) of petrels
Oct. 17	31°30'N.	176°30'W.	Flock (11-50 birds) of petrels and/or shearwaters
Oct. 17	31°50'N.	176°30'W.	Flock (200 birds) of terns, petrels and/or shearwaters working over unidentified tuna school
Oct. 19	33°00'N.	176°00'W.	Flock (100 birds) of petrels and/or shearwaters
Oct. 20	34°50'N.	175°30'W.	Flock (50 birds) of petrels
Oct. 20	35°00'N.	175°30'W.	Flock (100 birds) of petrels
Oct. 22	37°30'N.	175°00'W.	Flock (> 50 birds) of petrels and/or shearwaters
Oct. 22	37°30'N.	175°00'W.	Flock (> 50 birds) of petrels and/or shearwaters
Oct. 24	44°55'N.	177°50'W.	Flock (200-300 birds) of terns with few albatross
Oct. 25	40°10'N.	175°00'W.	Flock (> 300 birds) of petrels working over unidentified, large-sized tuna school
Dec. 19	23°40'N.	158°00'W.	Small school of medium-sized (approx. 7 lb.) tuna; no accompanying birds
1955			
Jan. 9	21°51'N.	168°46'W.	2 unidentified whales sighted
Jan. 12	21°20'N.	178°45'W.	Unidentified whale sighted
Jan. 14	29°35'N.	179°40'W.	School of small tuna (approx. 4 lb.) sighted; no birds present
Jan. 17	28°45'N.	169°55'E.	Unidentified fish (30-40 lb.) sighted breaking water
Jan. 18	35°48'N.	179°49'W.	Small, light brown turtle sighted near longline buoy
Jan. 27	31°41'N.	176°29'W.	Several killer whales sighted near longline set
Feb. 6	36°25'N.	173°15'W.	Flock (11-50 birds) of petrels with few Laysan albatross working over unidentified fish school
Feb. 7	33°30'N.	173°06'W.	Unidentified whale sighted

[1/] Observations have been listed chronologically and irrespective of locality or vessel. The numbers of birds sighted are estimates made by experienced fishermen.

Environmental Conditions

In the North Pacific, north of the Hawaiian Islands, there is a transition zone between two currents which may prove to be the significant oceanographic feature influencing the distribution and abundance of albacore. A detailed description of this zone for the winter of 1953-54 has been

given by McGary and Stroup (MS)[1/]. Briefly, it is an area of mixing created by shearing action between two easterly flowing currents, the Aleutian Current (relatively cold and low salinity water) to the north and the North Pacific Current (relatively warm and high salinity water) to the south. The zone is characterized by abrupt changes in temperature and salinity and by an increase in inorganic phosphate as compared with the North Pacific Current (McGary and Stroup MS). Increased biological activity is suggested by somewhat lower water transparency values (fig. 4) than prevail to the north and south.

Nearly all of the troll-caught albacore were taken within the transition zone (fig. 4), and the longline-caught albacore were taken either in the transition zone (fig. 5A) or just to the north (figs. 5B, 5C), suggesting a close

[1/] McGary, James W. and E. D. Stroup. Mid-Pacific oceanography, Part VIII, Middle latitude waters, January-March 1954. The authors point out that an adequate name for this zone has yet to be found. It has at times been called the Arctic Convergence and the North Polar Front.

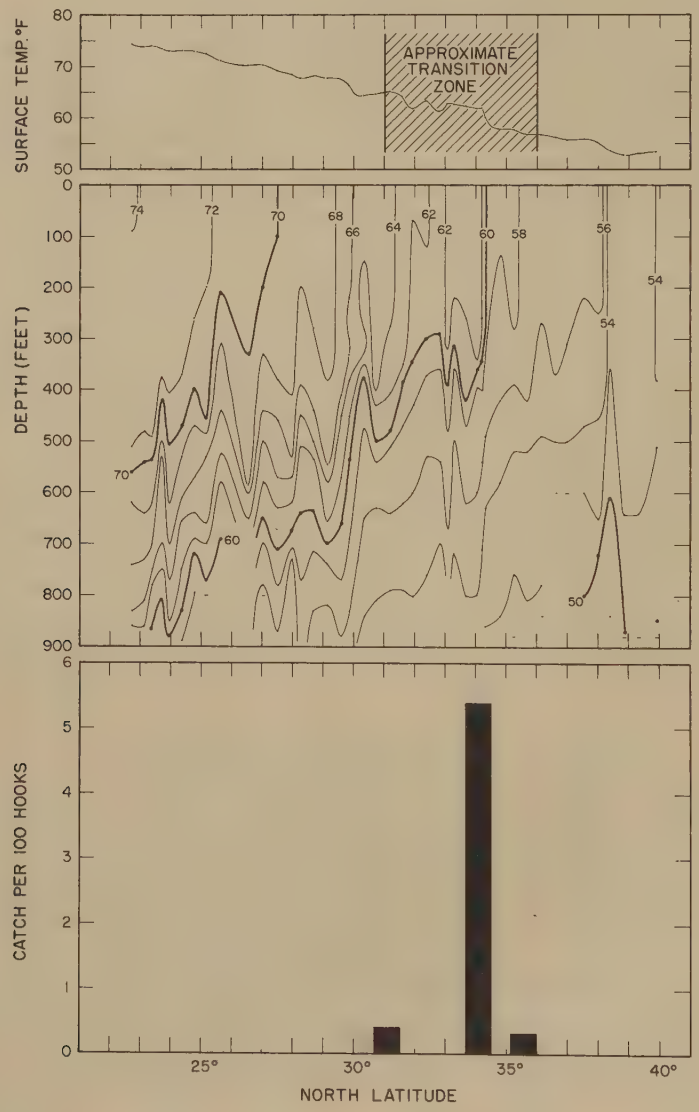

Figure 5A.--Vertical temperature sections and longline catch of albacore (catch/100 hooks) along 160°W. longitude during the three survey periods, Manning cruise 19, January-March 1954.

relationship between the albacore and this oceanographic feature.

The data from the three fishing cruises covered by this report give evidence that the transition zone undergoes seasonal meridional shifts, south in the winter and north in the fall. If the tuna are associated with this feature, they may be expected to show a similar seasonal shift in occurrence. In figure 5 the vertical temperature sections and the longline albacore catches along 160°W. longitude are shown for the three survey periods. During the winter of 1953-54 (fig. 5A) the transition zone was located approximately between 31° and 36°N. latitude, with the surface temperature varying between 58° and 64°F. During the fall of 1954 (fig. 5B) the transition zone had been displaced northward to between 41° and 46°N. latitude. The surface temperature in the transition zone during this period ranged from about 59° to 68°F. During the subsequent winter (1954-55) the transition zone again moved south to between 31° and 36°N. latitude, with the surface temperature varying from 58° to 69°F. (fig. 5C). The troll-catches of albacore, as shown in figures 4A-4C, show that the albacore were taken farther north in the fall than in the winter. The histograms in figures 5A-5C show a similar meridional shift in the location of the longline-caught albacore with season. Thus, the albacore appears to make seasonal meridional movements similar to the movement of the transition zone.

Table 6 shows the surface temperatures at which albacore were taken by trolling. Catches were most frequently made in temperatures between 59° and 61°F. These temperatures fall within the range which generally delineates the transition zone at the surface.

However, it should be pointed out that surface temperature alone cannot always be relied upon to indicate the presence of either albacore or the transition zone. This is clearly shown in the case of the high catch of 25 albacore

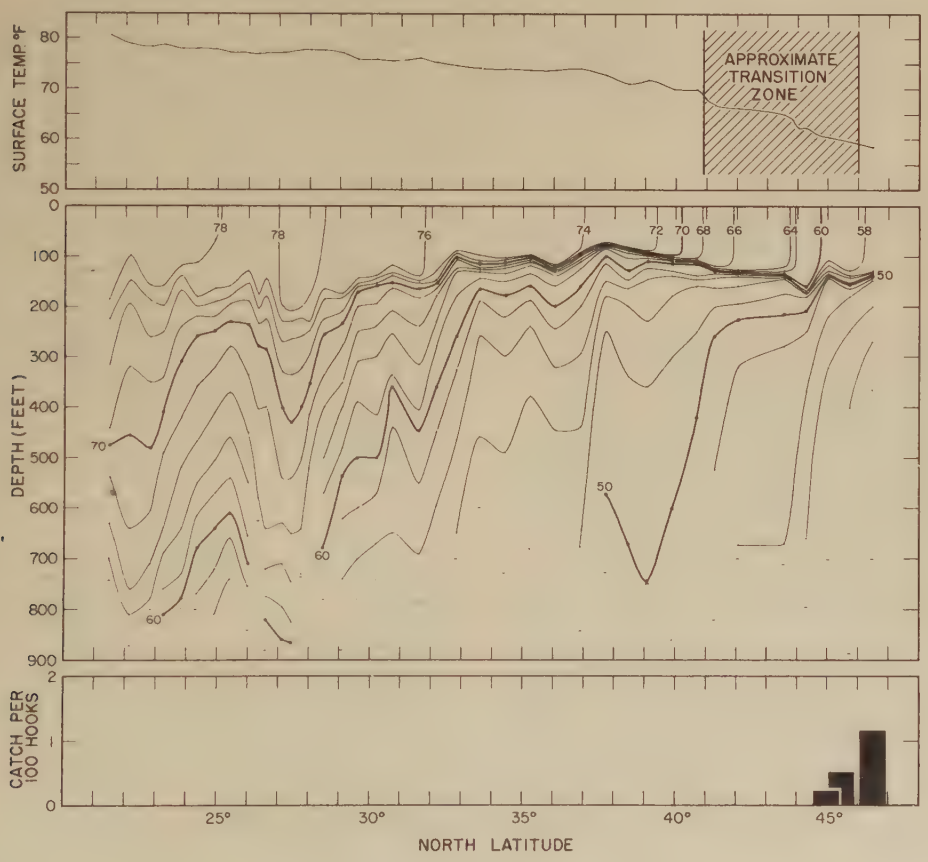

Figure 5B.--Vertical temperature sections and longline catch of albacore (catch/100 hooks) along 160°W. longitude during the three survey periods, Manning cruise 22, September-November 1954.

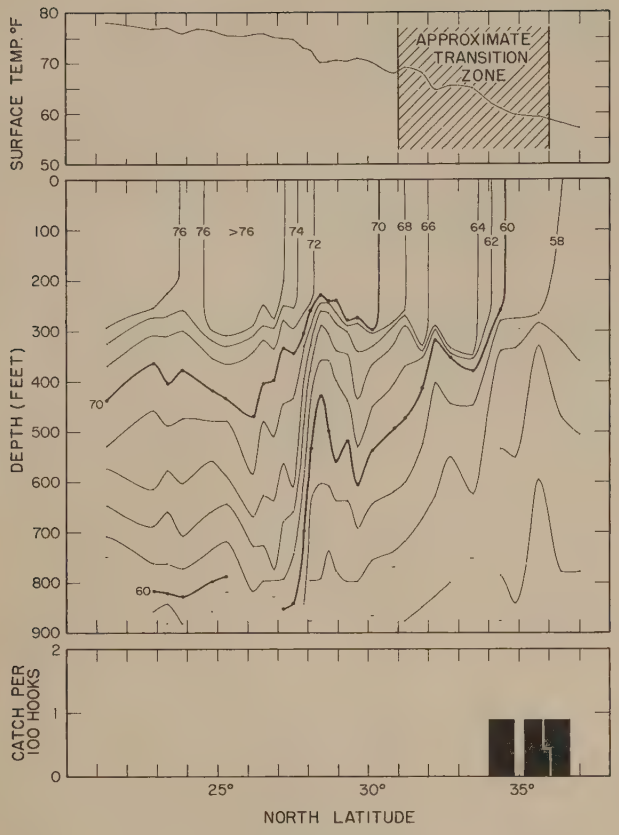

Figure 5C.--Vertical temperature sections and longline catch of albacore (catch/100 hooks) along 160°W. longitude during the three survey periods, Manning cruise 23, December 1954-February 1955.

Table 6.--Trolling catch of albacore in relation to surface temperature

Surface temperature	Number of albacore caught[1/]	Catch Total	Frequency of catch
°F.			
50	-	-	-
51	-	-	-
52	25, 2	27	2
53	1	1	1
54	-	-	-
55	-	-	-
56	-	-	-
57	2	2	1
58	-	-	-
59	1, 2, 3, 6, 2, 1, 1	16	7
60	1, 2, 1	4	3
61	1, 1	2	2
62	-	-	-
63	3	3	1
64	1, 2	3	2
65	1	1	1
66	-	-	-
Questionable	1	1	1
Total		60	21

[1/] Individual catches are listed to show the frequency of catches made at the various temperatures.

(8.8 per 10 line-hours of trolling) made at 42°N. on 172°E. longitude during the fall period (fig. 4B). In spite of the unusually low surface temperature of 52°F. this area was within the transition zone. This low temperature was probably the result of the mixing of surface and deeper waters associated with the recent passage of a low pressure cell with winds up to 65 knots.

Vertical Distribution of Albacore

Previous studies by POFI of the vertical distribution of tuna have been based on relative hook depth (Murphy and Shomura 1953a) because a method of routinely determining the absolute depth of the gear was lacking. On two of the three cruises discussed in this paper (Manning cruises 22 and 23) chemical sounding tubes were used to give direct measurements of the depth of fishing.

The sounding tubes were of glass capillary tubing, 4 mm. in outside diameter and 640 mm. in length with an inner chemical coating which dissolves upon contact with water. While in use, the tubes are encased in protective metal cylinders. When submerged, water is forced up the tube by the pressure, leaving a line of demarkation which indicates the maximum depth when the tube is read against a scale.

The accuracy of the calibration of the sounding tubes under conditions of prolonged immersion (i.e., 5 to 10 hours) was checked by attaching them to the longline together with a bathythermograph. The results of 26 tests are shown in figure 6. The agreement between the sounding tube readings and the bathythermograms suggests that the former may be used to determine the depth of the longline with reasonable accuracy. Variation of the points about the theoretical line shown in figure 6 is within the range of error of reading the two instruments.

To estimate routinely the fishing level of the longline gear, sounding tubes were

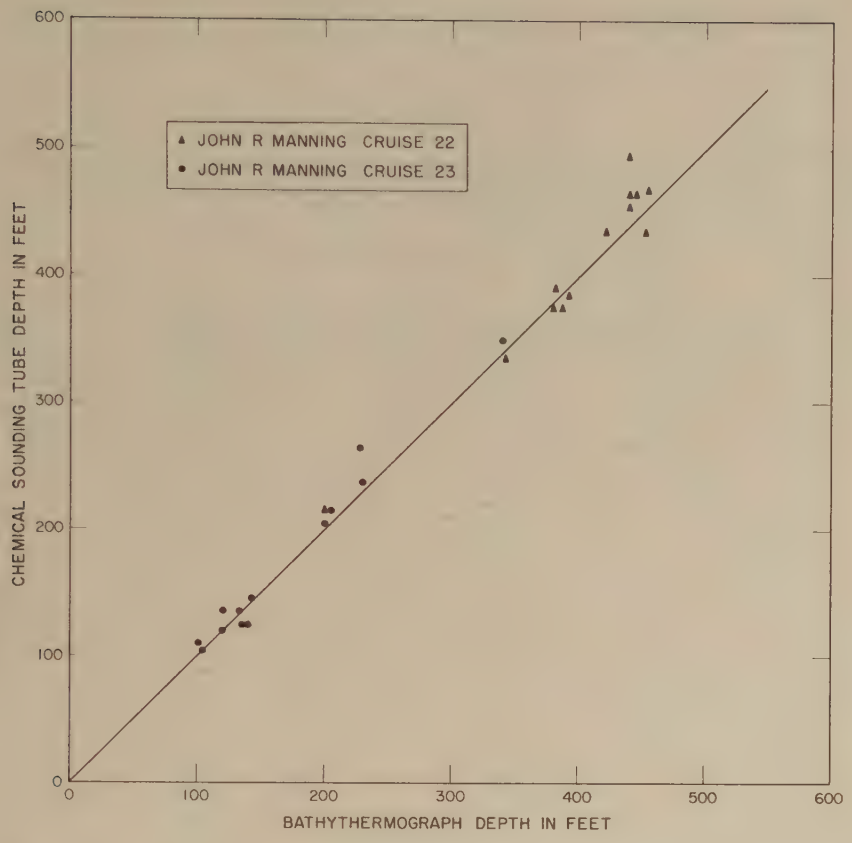

Figure 6.--Calibration of chemical sounding tubes with bathythermograph on John R. Manning cruises 22 and 23. Each point denotes readings obtained from one lowering of the BT with sounding tube attached.

attached to the proximal end of the deepest branch line (number 7) on 2 to 4 baskets at 31 stations during Manning cruises 22 and 23. They were placed on centrally located baskets of the 5- and 15-fathom floatline gear in order to avoid atypical measurements from the end baskets.

Table 7 (a, b) gives the depths recorded on the two cruises for both the 5- and 15-fathom floatline gear. On cruise 22 the maximum depth for the 5-fathom gear ranged from 306 to 504 feet and averaged 405 feet. The 15-fathom gear fished deeper, averaging 432 feet with a range of depths from 336 to 450 feet. On cruise 23 the difference was more pronounced, principally because the 5-fathom gear was set without the usual slack. The 5-fathom gear averaged 328 feet and ranged from 222 to 504 feet. The 15-fathom gear fished about 80 feet deeper, averaging 410 feet and ranging from 288 to 522 feet.

The albacore catches by relative depths of capture are given in table 8. In general, albacore were caught in approximately equal numbers throughout the range of fishing depths, a different situation from that in the equatorial region, where they are taken in the greatest numbers on the deepest hooks (Murphy and Shomura 1953b). This difference in the vertical distribution of the North Pacific albacore and equatorial albacore may be associated with the difference in water temperatures between the two areas. The water temperatures which occur at the surface in the North Pacific are found in the deeper layers near the Equator; e.g., the 60°F. isotherm which is at or near the surface in the North Pacific is located at depths exceeding 500 feet in equatorial waters (Murphy and Shomura 1953a, b). Thus even near the Equator, where albacore exist in sizeable numbers, they appear to occupy a similar environment temperature-wise as they do in the northern region.

A comparison of the maximum depth of fishing, the depth of the thermocline, and the albacore distribution by relative hook depth indicates that albacore may possibly be foraging

Table 7a.--Depth of deepest fishing hook of the 5- and 15-fathom floatline gear as estimated by chemical sounding tubes

John R. Manning cruise 22

Station	5-fathom floatline gear		15-fathom floatline gear		Thermocline depth
	No fish on basket	Fish on basket	No fish on basket	Fish on basket	
	feet	feet	feet	feet	feet
1	384	534	-	-	130
3	360	378	-	-	140
	384	-	-	-	-
5	-	-	450	-	130
	-	-	432	-	-
	-	-	450	-	-
7	-	444	-	-	90
	-	552	-	-	-
	-	432	-	-	-
9	450	-	-	-	100
	414	-	-	-	-
	432	-	-	-	-
11	384	408	-	-	120
	408	-	-	-	-
13	462	-	450	-	70
14	504	-	-	-	90
	408	-	-	-	-
	420	-	-	-	-
15	432	>600	-	-	100
	-	522	-	-	-
17[1/]	282	-	-	-	120
	288	-	-	-	-
18[1/]	-	360	336	-	100
	-	342	-	-	-
19	420	-	408	-	120
	384	-	-	-	-
21	384	396	-	-	100
	402	-	-	-	-
24	306	336	-	-	160
	342	-	-	-	-
26	414	450	402	402	200
28	-	414	-	444	220
	-	-	-	438	-
$\bar{x}$	405		432		

[1/] Not included in calculating the mean because of atypical setting prodecure.

Table 7b.--Depth of deepest fishing hook of the 5- and 15-fathom floatline gear as estimated by chemical sounding tubes (continued)

John R. Manning cruise 23

Station	5-fathom floatline gear		15-fathom floatline gear		Thermocline depth
	No fish on basket	Fish on basket	No fish on basket	Fish on basket	
	feet	feet	feet	feet	feet
1	420	-	-	414	265
	414	-	-	402	-
3	378	-	468	-	325
	336	-	474	-	-
5	348	-	-	450	260
	318	-	-	492	-
7	372	372	360	-	270
	-	-	492	-	-
8	270	-	390	492	280
	369	-	-	-	-
9	252	330	-	-	360
10	324	297	396	366	290
11	264	-	480	-	355
	-	-	342	-	-
12	222	-	297	378	230
	276	-	-	-	-
13	414	252	522	-	240
	-	-	288	-	-
14	360	-	390	-	260
	249	-	342	-	-
15	504	-	456	-	380
	276	-	426	-	-
16	315	-	372	360	470
	255	-	-	-	-
17	327	-	354	-	385
	354	-	522	-	-
18	249	324	468	-	320
	-	-	360	-	-
$\bar{x}$	328		410		

Table 8.--Summary of albacore catch by relative hook depth

a. Gear with 5-fathom floatlines

Cruise	Hook number						
	1 and 13	2 and 12	3 and 11	4 and 10	5 and 9	6 and 8	7
Manning-19 (Jan.-Mar. 1954)	2	3	4	3	2	7	4
Manning-22 (Sept.-Nov. 1954)	1	2	2	3	1	-	1
Manning-23 (Dec. 1954-Feb. 1955)	4	1	2	4	4	4	3

Table 8.--Summary of albacore catch by relative hook depth (continued)

b. Gear with 15-fathom float lines

Cruise	Hook number						
	1 and 13	2 and 12	3 and 11	4 and 10	5 and 9	6 and 8	7
Manning-19 (Jan.-Mar. 1954)	2	4	2	5	2	4	2
Manning-22 (Sept.-Nov. 1954)	4	6	1	-	2	2	-
Manning-23 (Dec. 1954-Feb. 1955)	3	2	2	6	5	6	4

below as well as above the thermocline in northern waters. It may be calculated from table 7 that on Manning cruise 22 the average maximum fishing depth of the 5-fathom gear was 405 feet, which was considerably deeper than the average thermocline depth of 124 feet, while on cruise 23 the average maximum depth of fishing (328 feet) was approximately at the depth of the thermocline (321 feet). On both cruises the 15-fathom gear was well below the thermocline, with an average maximum depth of 432 feet on cruise 22 and 410 feet on cruise 23. If it is accepted that the deeper hooks were fishing below the thermocline, the vertical distribution of the albacore catches (table 8) shows that some of them were caught below the thermocline. We cannot as yet accept these findings as final in view of the small catch and the possibility that all of the albacore could have been caught at shallower depths during the retrieving of the line. This question can only be settled with more data than are presently available.

Size of Albacore

The size distribution of the albacore taken in the North Pacific during the three survey periods is shown in figure 7 in which catches from longline and trolling gear are treated separately. It is seen that the longline-caught albacore had a wider size range than the troll-caught albacore. During the fall, troll catches ranged in size from 52 to 74 cm. (7 to 20 pounds) while the longline-caught albacore ranged from 54 to 114 cm. (8 to 68 pounds). This indicates that the trolling gear samples chiefly the smaller albacore, while both small and large fish are taken on the longline. We do not as yet know how efficiently the longline gear samples the smaller fish, nor whether or not the small fish were chance captures at the surface during the hauling of the line. But if small albacore were being taken only during hauling, then they should all have been alive when landed. However, only 17 of the 30 small albacore (less than 80 cm.)[2/] taken were landed alive, while among fish larger than 80 cm., 62 out of 88 were alive (table 9). The implication is that small albacore are not being taken only at the surface during the hauling of the gear.

Table 9.--Summary of longline-caught albacore landed alive

Cruise	Total number of albacore < 80 cm.	Number taken alive	Total number of albacore >80 cm.	Number taken alive
Manning-19 (Jan.-Mar. 1954)	3	-	41	30
Manning-22 (Sept.-Nov. 1954)	21	12	4	3
Manning-23 (Dec. 1954-Feb. 1955)	6	5	43	29
Total	30	17 57%	88	62 70%

A majority of the longline-caught albacore taken during the first winter (January-March 1954) were large, 93 percent of the catch measuring over 80 cm. (25 pounds). During the fall (September-October 1954) the reverse was true, with the catch made up mostly of small fish and with those larger than 80 cm. constituting only 19 percent of the catch. Finally, the results from

[2/] All troll-caught albacore measured less than 80 cm. (fig. 7) therefore it is assumed provisionally that 80 cm. is the approximate size at which "small" and "large" fish are separated.

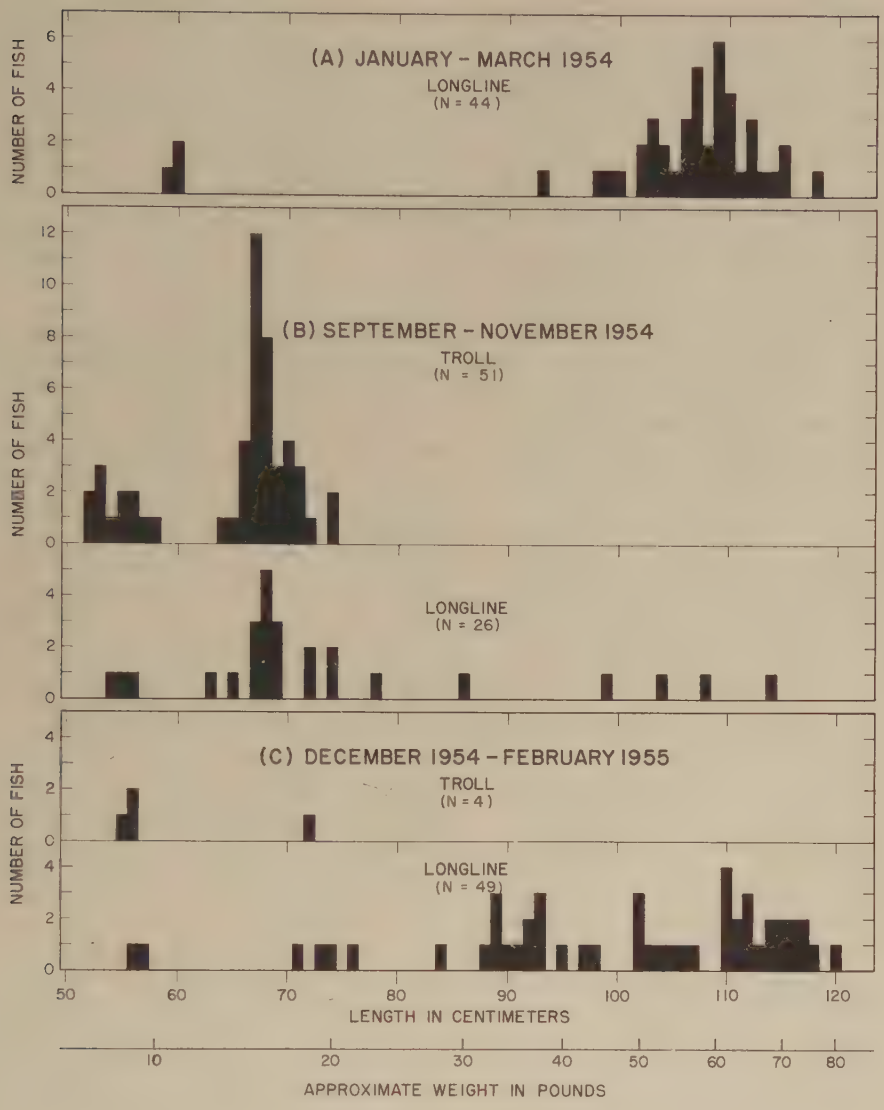

Figure 7.--Length frequency of albacore taken during the three surveys. A. January-March 1954, B. September-November 1954, C. December 1954-February 1955.

the second winter of fishing (December 1954-February 1955) again showed larger fish dominating the catch, with 88 percent of the albacore catch larger than 80 cm. The almost complete absence of small albacore (less than 80 cm.) from both the longline and trolling catches during both winters suggests that the small fish which were present during the fall had moved out of the area with the approach of winter.

Sex Ratio and Maturity of Albacore

The results of the albacore sex determinations are given in table 10. A paucity of

Table 10.--Sex of albacore taken on Manning cruises 19, 22, and 23

Cruise	Total number observed	Number of males	Number of females	Ratio (♂:♀)
Manning-19 (Jan.-Mar. 1954)	15	12	3	4:1
Manning-22 (Sept.-Nov. 1954)	11	5	6	1:1.2
Manning-23 (Dec. 1954-Feb. 1955)	14	12	2	6:1

data, further reduced by the tagging of viable albacore, precludes any analysis at this time. Field examination of the gonads failed to reveal sexually mature fish, most of them possessing thin, ribbon-like gonads in the earliest stages of sexual development.

Tagging of Albacore

One of the aims of the albacore investigation is to determine the relationships of the albacore taken in different parts of the North Pacific, i.e., whether the albacore population of the North Pacific is composed of one or many races or stocks of fish. Recoveries made by the Japanese of albacore tagged off California (Ganssle and Clemens 1953, Blunt 1954) demonstrate ocean-wide migrations. Notable among these is the recovery made on June 23, 1953, by Japanese fishermen about 550 miles southeast of Tokyo (Ganssle and Clemens 1953). This fish had been tagged and released off Los Angeles Harbor, California, on August 4, 1952, 324 days before recapture. The albacore had traversed a straight-line distance of 4,900 miles.

In order to define the relationship of the central Pacific stocks, we have tagged all viable albacore, thus far releasing 79 fish (table 20, Appendix). Tags (Type G) and tagging methods have been essentially the same as those used in California (Wilson 1953).

OTHER FISHES

Other Tunas

In addition to the albacore, the species of tuna taken on longline (tables 11 to 13, Appendix) and trolling (table 21, Appendix) gear were the bigeye, yellowfin, skipjack, and little tunny. Of these, the bigeye, which is of commercial importance in Hawaii and Japan, was by far the most abundant species in the longline catch. Bigeye appeared in the catch at 27 of the 52 stations fished, the biggest single catch (30 bigeye, or 3.85 fish per 100 hooks) being made on Manning cruise 19 at 30°54'N., 159°54'W., just south of the biggest albacore catch, which was made at 33°58'N. during the same period. The distributional pattern of the bigeye during the three survey periods (fig. 8) indicates a north-south shift paralleling that of the albacore; during the fall bigeye were taken as far north as 40°N., but during the winter they were taken only as far north as 34°N. (fig. 8). Bigeye and albacore were taken together at only 6 of the 41 stations which yielded tuna, and most of the bigeye were taken farther south than the albacore, indicating a preference for a more tropical environment.

Yellowfin and skipjack were sporadically taken on the longline and trolling gear and then generally south of the albacore, while the single little tunny was caught by trolling in definitely tropical waters. As for the small catch of yellowfin, Nakamura (1951) says that this species ranges as far north as 35°N. latitude and is abundant in the North Pacific during the summer, a period for which we do not at present have data.

Sharks

The four species of shark commonly taken on the longline gear in the North Pacific were the bonito, great blue, thresher, and white-tipped shark. Of the four species, the great blue was by far the most frequently caught and is probably the most abundant species of shark in the area. It was taken at 50 of the 52 fishing stations, with the highest day's catch of 40 at station 28 (40° 12'N., 174°56'W.) on cruise 22 of the Manning during October 1954 (tables 17 to 19, Appendix).

The immediate importance of sharks to the tuna longline fishery lies in the amount of damage they inflict on the tuna catch. In the equatorial area shark-damaged tuna comprise as much as 20 percent of the catch (Murphy and Shomura 1955). In comparison, only 3 of a total of 262 tuna (1.1 percent) taken on the longline gear in the North Pacific were shark-bitten, in spite of the heavy population of great blue shark indicated by the longline catches.

Miscellaneous Species

Among the miscellaneous species of fish taken on the longline gear were the lancet fish, broadbill swordfish, striped marlin, black marlin, short-nosed spearfish, sunfish, dolphin, wahoo, and a newly described species of pelagic sting ray (Ishiyama and Okada 1955). Only the lancet fish, among these, were taken with any regularity (tables 17 to 19, Appendix), and they were found to range widely over the areas fished.

One pelagic sting ray was captured at station 15 (cruise 19) at 34°41'N., 154°52'W. and another at station 13 (cruise 23) at 33°50'N., 179°44'W.

Among the troll catches of fish other than tunas (table 22, Appendix) the dolphin was most frequent. It was taken in the southern sectors of the survey areas.

SUMMARY

1. Albacore were taken on the longline gear during all three surveys, with the highest

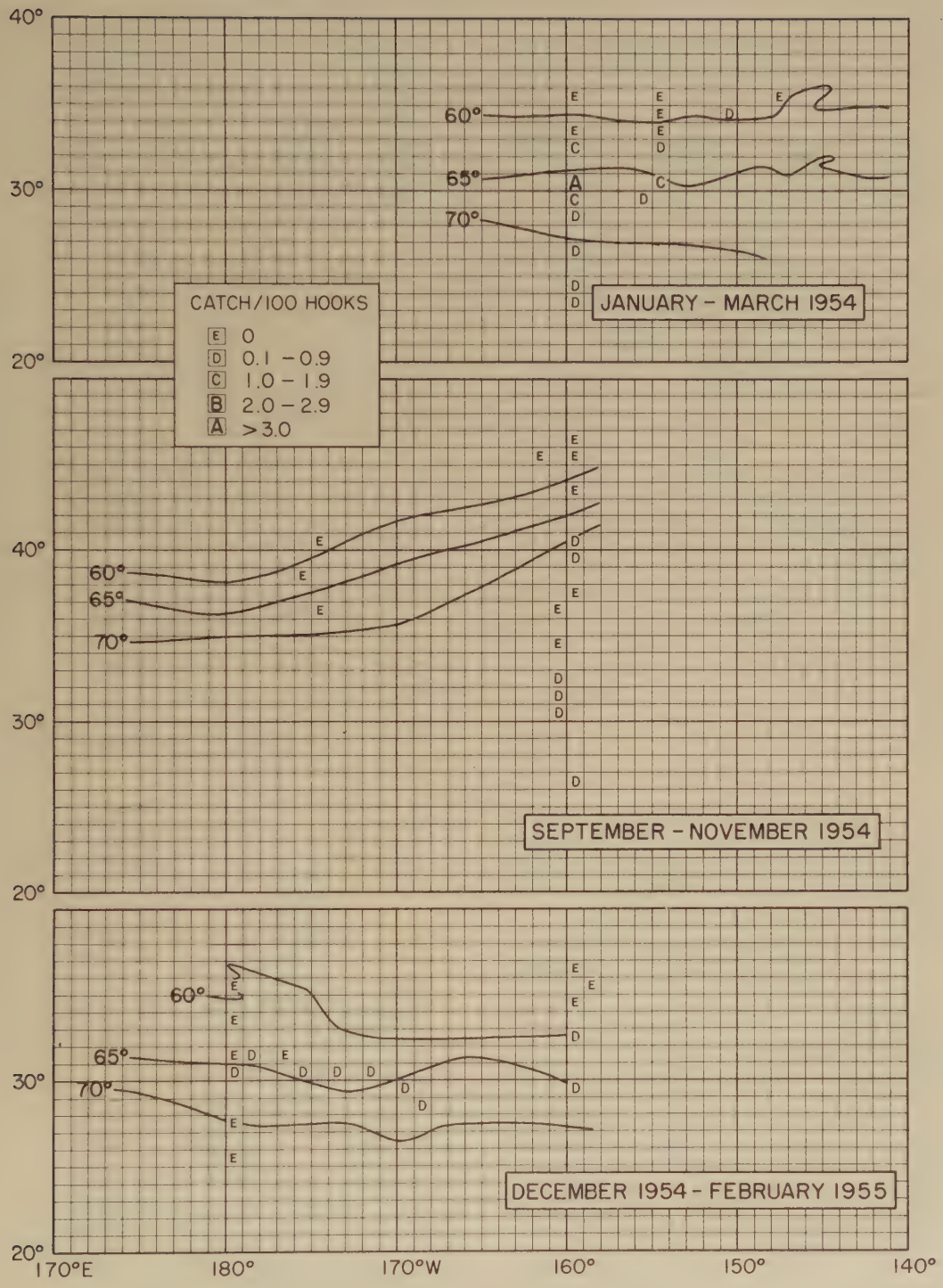

Figure 8. --Summary of POFI longline bigeye catches in the North Pacific.

single catch of 42 albacore made during the first winter of fishing. As evidenced by Japanese catch data, substantial numbers of albacore were present as far west as 141°E. longitude during the winter of 1953-54.

2. Trolling for albacore was most successful during the fall survey, with the highest catch of 8.8 albacore per 10 line-hours of trolling made at 42°N., 172°E. Trolling during both winter surveys was poor. No albacore were taken during the first winter and only 4 during the second winter of fishing.

3. The albacore population moves north and south seasonally. Fish were taken only north of 35°N. latitude during the fall but were taken as far south as 29°N. latitude during the winter. This shift in albacore distribution appears to be related to a similar latitudinal shift in the transition zone, which is a zone of mixing between two easterly flowing currents, the North Pacific and the Aleutian. During the fall the transition zone was considerable farther north than during the winter.

4. A study of the vertical stratification of albacore indicated their presence throughout the range of depths fished by the longline gear.

5. By means of chemical sounding tubes the average maximum depth of the 5-fathom floatline gear was found to be 405 feet on Manning cruise 22 and 328 feet on Manning cruise 23. The average maximum depth of the 15-fathom floatline gear was 432 feet and 410 feet for the two cruises respectively.

6. The albacore taken on the longline gear ranged in size from 54 to 120 cm. (8 to 79 pounds), while all of the troll-caught albacore were smaller than 74 cm. (20 pounds). The majority of the small albacore (less than 80 cm.) were taken on the longline and trolling gear during the fall survey, and they were noticeably absent from both winter surveys, indicating a movement of small albacore from the area.

7. None of the albacore taken on the longline or trolling gear were in an advanced stage of sexual maturity.

8. A total of 79 albacore, 54 bigeye, and 1 yellowfin were tagged with the California-type plastic vinylite tags.

9. Bigeye tuna were regularly taken during all three survey periods, usually south of the area of albacore catches. The bigeye ranged in size from 82 to 180 cm. (26 to 265 pounds).

10. Damage to longline-caught fish by sharks was negligible at 1.1 percent even though shark populations were apparently quite large. Shark damage in equatorial waters often reaches as high as 20 percent.

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APPENDIX

Table 11.--Summary of the tuna catch, John R. Manning cruise 19[1/], January-March 1954

Station	Date	Noon position		Catch per 100 hooks			
		Latitude	Longitude	Albacore	Bigeye	Yellowfin	Skipjack
1	Jan. 16	23°36'N.	159°148W.	-	0.40	-	-
2	Jan. 21	24°50'N.	159°40'W.	-	0.26	0.26	-
3	Jan. 22	26°28'N.	159°39'W.	-	0.13	-	-
4	Jan. 23	28°12'N.	159°44'W.	-	0.40	0.13	0.26
5	Jan. 24	29°44'N.	159°56'W.	-	1.79	-	-
6	Jan. 25	30°54'N.	159°54'W.	0.40	3.85	-	0.13
7	Jan. 26	32°29'N.	159°50'W.	-	1.92	-	-
8	Jan. 27	33°58'N.	159°44'W.	5.38	-	-	-
9	Jan. 28	35°27'N.	159°38'W.	0.26	-	-	-
10	Feb. 19	29°07'N.	155°12'W.	-	0.51	-	-
11	Feb. 20	30°36'N.	154°50'W.	-	1.03	-	0.13
12	Feb. 21	32°12'N.	154°48'W.	-	0.77	-	-
13	Feb. 22	32°43'N.	154°50'W.	-	0.26	-	-
14	Feb. 25	33°46'N.	154°48'W.	-	-	-	-
15	Feb. 26	34°41'N.	154°52'W.	-	-	-	-
16	Feb. 27	35°16'N.	155°02'W.	-	-	-	-
17	Mar. 1	34°02'N.	150°26'W.	-	0.26	-	-
18	Mar. 3	35°57'N.	147°00'W.	-	-	-	-

[1/] 13 hooks per basket; 754 hooks fished at station 1, 780 hooks at all others.

Table 12.--Summary of the tuna catch, Manning cruise 22, September-October 1954

Station	Date	Noon position		Number of hooks	Catch per 100 hooks	
		Latitude	Longitude		Albacore	Bigeye
1	Sept. 15	26°17'N.	159°13'W.	780	-	0.64
3	Sept. 17	30°14'N.	160°05'W.	780	-	0.38
5	Sept. 18	31°26'N.	160°07'W.	780	-	0.64
7	Sept. 19	32°50'N.	160°05'W.	728	-	0.27
9	Sept. 20	34°25'N.	160°01'W.	780	-	-
11	Sept. 21	36°02'N.	160°05'W.	780	-	-
13	Sept. 22	37°43'N.	159°31'W.	780	-	-
14	Sept. 23	39°02'N.	159°38'W.	780	-	0.26
15	Sept. 24	40°45'N.	159°50'W.	780	-	0.64
17	Oct. 2	43°37'N.	159°43'W.	520	-	-
18	Oct. 3	45°02'N.	159°40'W.	520	0.19	-
19	Oct. 4	46°30'N.	159°18'W.	780	1.15	-
21	Oct. 5	45°31'N.	161°16'W.	780	0.51	-
24	Oct. 21	36°22'N.	174°35'W.	780	0.38	-
26	Oct. 24	38°40'N.	175°27'W.	767	1.17	-
28	Oct. 25	40°12'N.	174°56'W.	754	0.13	-

Table 13.--Summary of the tuna catch, John R. Manning cruise 23, December 1954-February 1955

Station	Date	Noon position		Number of hooks	Catch per 100 hooks	
		Latitude	Longitude		Albacore	Bigeye
1	Dec. 6	29°32'N.	159°56'W.	715	-	0.70
3	Dec. 8	32°43'N.	159°54'W.	780	-	0.13
5	Dec. 9	34°23'N.	159°48'W.	780	0.90	-
7	Dec. 12	36°14'N.	159°54'W.	780	0.90	-
8	Dec. 14	35°35'N.	158°21'W.	780	0.90	-
9	Jan. 12	25°52'N.	179°26'W.	773	-	-
10	Jan. 13	27°51'N.	179°30'W.	780	-	-
11	Jan. 15	30°25'N.	179°42'E.	520	0.38	0.38
12	Jan. 16	31°49'N.	179°43'E.	520	0.96	-
13	Jan. 17	33°50'N.	179°44'W.	773	0.13	-
14	Jan. 18	35°48'N.	179°49'W.	754	0.27	-
15	Jan. 20	31°25'N.	178°08'W.	780	0.64	0.13
16	Jan. 27	31°41'N.	176°29'W.	780	-	-
17	Jan. 28	30°42'N.	175°01'W.	780	1.03	0.13
18	Jan. 30	30°52'N.	173°10'W.	780	-	0.13
19	Jan. 31	30°59'N.	171°14'W.	780	0.51	0.64
20	Feb. 1	29°30'N.	169°47'W.	780	0.26	0.13
21	Feb. 2	28°21'N.	168°08'W.	780	-	0.26

Table 14.--Time taken for setting and hauling the longline gear, John R. Manning cruise 19, January-March 1954

Station	Set				Haul			Fish-handling break
	Number of baskets set		Time started to set	Time taken for setting	Time started to haul	Time taken for hauling		
	5-fathom gear	15-fathom gear				5-fathom gear	15-fathom gear	
				min.		min.	min.	min.
1	28	30	0653	87	1236	129	108	30
2	30	30	0655	86	1229	119	130	27
3	30	30	0700	84	1229	111	122	28
4	30	30	0649	78	1257	96	100	27
5	30	30	0647	80	1230	102	105	33
6	30	30	0648	84	1228	110	110	31
7	30	30	0647	81	1228	109	113	31
8	30	30	0645	78	1239	94	120	37
9	30	30	0654	78	1225	111	108	31
10	30	30	0614	80	1220	106	137	32
11	30	30	0615	80	1216	119	137	28
12	30	30	0619	81	1220	104	120	-
13	30	30	0622	83	1211	140	176	-
14	30	30	0618	82	1213	111	110	33
15	30	30	0625	82	1208	106	119	36
16	30	30	0618	82	1213	125	125	33
17	30	30	0613	83	1302	135	113	-
18	30	30	0615	85	1209	126	130	20

Table 15.--Time taken for setting and hauling the longline gear, John R. Manning cruise 22, September-November 1954

Station	Set				Haul			Fish-handling break
	Number of baskets set		Time started to set	Time taken for setting	Time started to haul	Time taken for hauling		
	5-fathom gear	15-fathom gear				5-fathom gear	15-fathom gear	
				min.		min.	min.	min.
1	30	30	0532	78	1213	120	135	35
3	30	30	0538	77	1234	107	120	29
5	30	30	0540	79	1227	129	125	27
7	27	29	0544	74	1213	102	112	30
9	30	30	0546	74	1219	107	97	28
11	30	30	0540	74	1208	114	106	30
13	30	30	0543	77	1216	113	111	-
14	30	30	0544	71	1218	114	124	-
15	30	30	0602	73	1211	156	126	29
17	20	20	0618	68	1215	95	100	-
18	20	20	0646	60	1226	85	95	-
19	30	30	0546	76	1205	116	109	-
21	30	30	0601	78	1217	132	126	-
24	30	30	0635	85	1210	102	111	-
26	30	29	0627	78	1225	136	117	24
28[1/]	30	30	0620	80	1203	-	-	-

[1/] Gear picked up in severe storm, 2 baskets lost, hauling times for some baskets not recorded.

Table 16.--Time taken for setting and hauling the longline gear, John R. Manning cruise 23, December 1954-February 1955

Station	Set				Haul			Fish-handling break
	Number of baskets set		Time started to set	Time taken for setting	Time started to haul	Time taken for hauling		
	5-fathom gear	15-fathom gear				5-fathom gear	15-fathom gear	
				min.		min.	min.	min.
1	25	30	0648	82	1156	125	129	32
3	30	30	0612	86	1217	127	128	36
5	30	30	0605	83	1223	126	118	33
7	30	30	0700	82	1217	119	117	27
8	30	30	0606	81	1205	242	134	23
9	30	30	0612	96	1130	118	142	23
10	30	30	0615	87	1154	114	121	27
11	20	20	0700	65	1200	87	73	26
12	20	20	0742	59	1202	72	93	-
13	30	30	0642	94	1155	114	103	23
14	28	30	0630	85	1201	94	109	24
15	30	30	0632	90	1153	113	119	19
16	30	30	0615	91	1135	108	119	31
17	30	30	0620	93	1150	116	126	23
18	30	30	0620	98 1/	1154	118	100	21
19	30	30	0624	86	1155	100	100	40
20	30	30	0619	77	1147	94	122	26
21	30	30	0610	81	1145	105	110	27

1/ Includes 15 minutes spent in repairing a line-break during setting

Table 17a.--Complete catch records, John R. Manning cruise 19, 5-fathom float line gear

Station	Baskets set	Albacore	Bigeye	Yellowfin	Skipjack	Broadbill	Dolphin	Lancet fish	Great blue shark	Others
1	28	-	1	-	-	-	-	-	-	-
2	30	-	1	2	-	-	1	-	2	1 1/
3	30	-	1	-	-	-	-	1	-	1 1/
4	30	-	-	-	1	-	-	1	1	-
5	30	-	3	-	-	-	-	2	5	1 2/
6	30	3	15	-	1	-	-	1	2	-
7	30	-	5	-	-	-	-	1	6	-
8	30	22	-	-	-	-	-	1	-	1 3/
9	30	1	-	-	-	-	-	2	3	-
10	30	-	-	-	-	-	-	5	-	-
11	30	-	3	-	-	-	-	8	2	-
12	30	-	2	-	-	-	-	1	2	-
13	30	-	-	-	-	-	-	1	6	-
14	30	-	-	-	-	-	-	2	6	-
15	30	-	-	-	-	-	-	3	1	1 4/
16	30	-	-	-	-	-	-	13	1	-
17	30	-	2	-	-	-	-	2	6	-
18	30	-	-	-	-	-	-	9	4	1 4/
Total		26	33	2	2	0	1	53	47	6

1/ Sunfish
2/ Bonito shark
3/ Striped marlin
4/ Thresher shark

Table 17b.--Complete catch records, John R. Manning cruise 19, 15-fathom float line gear

Station	Baskets set	Albacore	Bigeye	Yellowfin	Skipjack	Broadbill	Dolphin	Lancet fish	Great blue shark	Others
1	30	-	2	-	-	-	1	-	-	2 1/
2	30	-	1	-	-	-	-	-	-	2 2/
3	30	-	-	-	-	-	-	2	1	2 3/
4	30	-	3	1	1	-	-	1	-	-
5	30	-	11	-	-	-	-	5	2	-
6	30	-	15	-	-	-	-	-	2	-
7	30	-	10	-	-	-	-	-	5	1 4/
8	30	20	-	-	-	-	-	-	2	2 5/
9	30	1	-	-	-	-	-	1	5	-
10	30	-	4	-	-	-	-	10	1	-
11	30	-	5	-	1	-	-	4	-	-
12	30	-	4	-	-	-	-	-	-	-
13	30	-	2	-	-	1	-	5	7	-
14	30	-	-	-	-	-	-	5	6	-
15	30	-	-	-	-	-	-	3	4	2 6/
16	30	-	-	-	-	-	-	5	2	2 4/
17	30	-	-	-	-	1	-	3	2	1 4/
18	30	-	-	-	-	-	-	11	5	-
Total		21	57	1	2	2	1	55	44	14

1/ White-tipped shark
2/ Wahoo, white-tipped shark
3/ Bonito shark
4/ Thresher shark
5/ Sunfish, bonito shark
6/ Sting ray, thresher shark

Table 18a.--Complete catch record, John R. Manning cruise 22, 5-fathom float line gear

Station	Baskets set	Albacore	Bigeye	Spearfish	Dolphin	Great blue shark	Mako shark	Lancet fish	Others
1	30	-	2	-	2	1	-	1	-
3	30	-	3	1 1/	1	1	-	4	1 2/
5	30	-	3	-	2	4	-	2	-
7	27	-	-	-	4	4	1	9	1 3/
9	30	-	-	-	1	3	1	3	-
11	30	-	-	2 4/	1	1	-	2	-
13	30	-	-	-	-	-	1	1	-
14	30	-	1	-	-	4	-	-	-
15	30	-	4	1 4/	1	8	-	1	-
17	20	-	-	-	-	6	1	1	-
18	20	-	-	-	-	6	-	-	-
19	30	4	-	-	-	11	-	-	-
21	30	2	-	-	-	8	-	1	-
24	30	-	-	-	-	4	-	-	-
26	30	4	-	-	-	14	-	1	-
28 5/	30 5/	-	-	-	-	20	-	-	-
Total		10	13	4	12	95	4	26	2

1/ Black marlin
2/ White-tipped shark
3/ Wahoo
4/ Striped marlin
5/ Catch of 1 albacore and 3 great blue sharks--type of gear undetermined
6/ Lost 2 baskets of gear

Table 18b.--Complete catch record, John R. Manning cruise 22, 15-fathom float line gear

Station	Baskets set	Albacore	Bigeye	Spearfish	Dolphin	Great blue shark	Mako shark	Lancet fish	Others
1	30	-	3	1 1/	4	2	-	1	-
3	30	-	-	1 2/	2	1	-	2	-
5	30	-	2	-	7	7	-	5	-
7	29	-	2	-	2	3	-	5	-
9	30	-	-	-	1	4	-	4	-
11	30	-	-	-	-	1	2	1	-
13	30	-	-	-	-	3	-	2	-
14	30	-	1	-	-	6	-	1	-
15	30	-	1	-	2	4	-	3	-
17	20	-	-	-	-	8	-	-	-
18	20	1	-	-	-	3	-	6	-
19	30	5	-	-	-	7	-	1	-
21	30	2	-	-	-	4	-	-	-
24	30	3	-	-	-	1	-	-	-
26	29	5	-	-	-	4	-	1	-
28	30	-	-	-	-	17	-	1	-
Total		16	9	2	18	75	2	33	0

1/ Broadbill
2/ Black marlin

Table 19a.--Complete catch record, John R. Manning cruise 23, 5-fathom float line gear

Station	Baskets set	Albacore	Bigeye	Spearfish	Dolphin	Great blue shark	Mako shark	Lancet fish	Others
1	25	-	2	-	-	-	-	-	-
3	30	-	-	-	-	2	-	3	-
5	30	5	-	-	-	5	-	3	1 1/
7	30	4	-	-	-	-	-	5	-
8	30	1	-	-	-	9	-	5	-
9	30	-	-	-	-	3	-	-	-
10	30	-	-	-	1	19	-	-	-
11	20	1	2	-	-	3	-	1	-
12	20	3	-	-	-	3	-	-	-
13	30 2/	-	-	-	-	3	1	2	1 3/
14	28	-	-	-	-	2	-	-	-
15	30	2	-	-	-	1	-	-	-
16	30	-	-	-	-	-	-	2	-
17	30	3	-	-	-	1	-	-	-
18	30	-	1	-	-	3	-	-	-
19	30	2	4	-	-	1	1	-	-
20	30	1	1	-	-	-	-	-	-
21	30	-	-	1 4/	-	6	-	1	-
Total		22	10	1	1	61	2	22	2

1/ Thresher shark
2/ Lost half a basket of gear (6 hooks)
3/ Pelagic sting ray
4/ Shortnosed spearfish

Table 19b.--Complete catch record, John R. Manning cruise 23, 15-fathom float line gear

Station	Baskets set	Albacore	Bigeye	Spearfish	Dolphin	Great blue shark	Mako shark	Lancet fish	Others
1	30	-	3	1 SM	-	-	-	3	-
3	30	-	1	-	-	-	-	2	-
5	30	2	-	-	-	8	-	3	-
7	30	3	-	-	-	1	-	3	-
8	30	6	-	-	-	6	-	2	-
9	30[1/]	-	-	-	-	14	-	1	-
10	30	-	-	-	-	11	-	-	-
11	20	1	-	-	-	2	-	-	-
12	20	2	-	-	-	3	-	-	-
13	30	1	-	-	-	1	-	4	-
14	30	2	-	-	-	2	-	-	-
15	30	3	1	-	-	2	-	-	-
16	30	-	-	-	-	4	-	2	-
17	30	5	1	-	-	1	-	1	-
18	30	-	-	-	-	2	-	2	-
19	30	2	1	-	-	1	-	1	-
20	30	1	-	-	-	1	-	3	-
21	30	-	2	-	-	11	-	1	-
Total		28	9	1	0	70	0	28	0

[1/] Lost half a basket of gear (6 hooks)

Table 20.--Record of tuna tagged during John R. Manning cruises 19, 22 and 23

Species	JRM 19	JRM 22	JRM 23	Total
Albacore	26	18	35	79
Yellowfin	0	1	0	1
Bigeye	41	6	7	54

Table 21.--Summary of dates, locations, and surface water temperatures for troll catches of tuna other than albacore

Species and cruise	Date	Position		Surface temperature
		Latitude	Longitude	°F.
Yellowfin				
Manning 22	10/13/54	Off Midway I.		-
	11/1/54	31°38'N.	176°39'W.	72.6
Gilbert 17	11/7/54	21°23'N.	158°35'W.	79.9
	"	"	"	"
Skipjack				
Manning 22	11/4/54	26°32'N.	173°44'W.	75.0
Gilbert 17	10/28/54	34°33'N.	171°32'W.	68.7
Manning 23	1/26/55	30°23'N.	176°50'W.	65.1
Smith 27	1/18/55	32°00'N.	178°37'W.	63.4
	2/1/55	28°59'N.	179°19'W.	68.0
	2/2/55	32°03'N.	179°35'E.	64.8
	"	"	"	"
	"	"	"	"
	2/8/55	30°04'N.	172°50'W.	62.9
	2/13/55	31°10'N.	166°45'W.	62.3
Little tunny				
Manning 22	10/16/54	Off Midway I.		-

Table 22.--Summary of data on troll captures of miscellaneous species

Cruise	Date	Species	Position		Surface temperature
			Latitude	Longitude	°F.
JRM 22	9/15/54	Dolphin	26°20'N.	159°12'W.	76.9
"	"	"	"	"	"
"	"	"	"	"	"
"	9/23/54	"	39°07'N.	159°50'W.	71.7
"	"	"	"	"	"
"	9/24/54	"	40°44'N.	159°53'W.	69.9
"	"	"	"	"	"
"	11/1/54	Wahoo	31°38'N.	176°39'W.	72.6
"	"	Dolphin	"	"	"
"	11/2/54	"	28°59'N.	177°12'W.	74.0
"	11/4/54	Barracuda	26°52'N.	174°14'W.	76.4
JRM 23	12/6/54	Dolphin	29°32'N.	159°56'W.	70.3
"	"	"	"	"	"
"	"	"	"	"	"
CHG 17	9/19/54	"	25°13'N.	159°53'W.	77.2
"	"	"	"	"	"
"	"	"	"	"	"
"	"	"	"	"	"
"	9/24/54	"	39°25'N.	160°08'W.	70.5
"	11/1/54	"	28°03'N.	179°10'W.	77.0
"	11/2/54	"	27°02'N.	175°27'W.	77.5
"	"	Wahoo	26°53'N.	175°02'W.	77.6
"	11/3/54	Rainbow runner	25°55'N.	172°09'W.	78.5
HMS 27	2/19/55	Dolphin	28°00'N.	159°03'W.	69.6
"	2/20/55	"	26°03'N.	158°45'W.	70.5
"	"	"	"	"	"

Table 23.--Vernacular names of fishes and their commonly accepted scientific names

Albacore, Germo alalunga (Bonnaterre)
Bigeye tuna, Parathunnus sibi (Temminck and Schlegel)
Yellowfin tuna, Neothunnus macropterus (Temminck and Schlegel)
Skipjack, Katsuwonus pelamis (Linnaeus)
Little tunny, Euthynnus affinis (Cantor)
Black marlin, Makaira ampla (Poey)
Striped marlin, Makaira mitsukurii (Jordan and Snyder)
Shortnosed spearfish, Tetrapturus angustirostris (Tanaka)
Broadbill swordfish, Xiphias gladius Linnaeus
Dolphin, Coryphaena hippurus (Linnaeus)
Wahoo, Acanthocybium solandri (Cuvier and Valenciennes)
Barracuda, Sphyraena sp.
Great blue shark, Prionace glauca (Linnaeus)
Bonito shark, Isurus sp.
Thresher shark, Alopias sp.
White-tipped shark, Carcharinus longimanus (Poey)
Lancet fish, Alepisaurus sp.
Rainbow runner, Elagatis bipinnulatus (Quoy and Gaimard)
Sunfish, Mola mola Linnaeus and Ranzania sp.
Pelagic sting ray, Dasyatis atratus (Ishiyama and Okada)